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UNITED STATES DEPARTMENT OF AGRICULTURE
BUREAU OF AGRICULTURAL ECONOMICS

Operations Guidance Report on

WATER FACILITIES FOR
NORTH CANADIAN RIVER WATERSHED
HARPER AND ELLIS COUNTIES
OKLAHOMA

Prepared by

WATER UTILIZATION SECTION
DIVISION OF LAND ECONOMICS

September 1953

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WATER FACILITIES FOR NORTH CANADIAN RIVER WATERSHED HARPER AND ELLIS COUNTIES OKLAHOMA

Prepared by

WATER UTILIZATION SECTION
DIVISION OF LAND ECONOMICS

Under the Provisions of the
Water Facilities Act
(Public Law No. 399, 75th Congress)

September 1939

AUTHORIZATION

This report has been prepared under the provisions of the Water Facilities Act, Public Law No. 399, 75th Congress. The Water Facilities Act authorized the Secretary of Agriculture to formulate a program for the development of small water facilities and further authorized the Secretary of Agriculture to assign responsibility for the operation of the Program.

In a memorandum from the Secretary dated July 1, 1938, responsibility for the preparation of area plans for specific areas selected by the Water Facilities Board was assigned to the Bureau of Agricultural Economics.

The Water Facilities Board approved for planning May 24, 1939, an area which includes the southwestern portion of Harper County and the northwestern portion of Ellis County, Oklahoma.

This report has been prepared subject to the above cited authorities and responsibility assigned to the Bureau of Agricultural Economics.

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CONCLUSIONS AND RECOMMENDATIONS

1. The average annual precipitation over the area is estimated to be about 22 inches.

2. The average annual surface run-off per square mile of drainage area is estimated as follows:

    a. "Red bed" areas......................46 acre-feet

    b. "Other" areas.......................23 acre-feet

3. It is recommended that surface water development in the area consist of:

    a. Construction of small dams and reservoirs for stock purposes.

    b. Flood irrigation of native pastures.

4. Ground-water development in the area is recommended as follows:

    a. Development of both stock and domestic supplies in all Quaternary and Tertiary areas.

    b. Development of stock supplies only in the "red bed" areas.

5. It is recommended that ground-water development for irrigation purposes in the alluvium area along Beaver Creek be delayed, pending results of court action as stated on page 17 of this report.

PURPOSE AND SCOPE

The purpose of this report is to indicate, in a preliminary manner, the agricultural utilization of the available water resources.

Data contained in this report were obtained in reconnaissance studies. While additional information would allow recommendations to be made in greater detail, it is believed that the recommendations herein contained are reliable and have sufficient accuracy for the purpose of pointing the direction which the action program should take.

DESCRIPTION OF AREA

Location

The area discussed in this report lies in southwestern Harper County and northwestern Ellis County, Oklahoma, but excluding the Wolf Creek drainage basin in Ellis County, which is also tributary to the North Canadian River. The area includes all other tributaries of the North Canadian River in Harper and Ellis counties down to the point of confluence of Wolf Creek with the North Canadian River. The North Canadian River is known locally as the Beaver River. The area lies between 36° 15' and 37° 00' north latitude and 99° 30' and 100°00' west longitude.

The area includes 392 square miles or 250,880 acres. The principal town is Laverne, Oklahoma, with a population of nearly 1,000. Other small unincorporated towns are May, Dunlap, Catsby, and Speermore.

Topography

The area varies in topography from slightly rolling to undulating with a general surface slope to the northeast. A portion of the Plains border section of the Great Plains province extends

into northern Ellis County from the west. This upland plain merges sharply into the basin of the North Canadian River to furnish considerable topographic relief.

Along the south bank of the North Canadian River the topography is characterized by terrace lands locally suitable for irrigation practices. Characteristics of the north bank differ widely, sand dunes rising abruptly from the stream level to a height of 75 to 100 feet.

Elevations

From profile sheets of the North Canadian River[1] the elevation at the confluence of Kiowa Creek and the North Canadian River is approximately 2,100 feet, at Laverne 2,075 feet, and at Supply 1,950 feet. The elvation of Catsby, in the southwestern corner of the area, is approximately 2,350 feet.

Drainage Pattern

The area is drained by the North Canadian River and its tributaries. Kiowa, Clear, Otter, and Sand Creeks drain the area south of the North Canadian River while three or four very small creeks drain the sand dune belt adjacent to the river on the north side.

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[1] Arkansas River and Tributaries. 74th Congress, 1st Session, House Document No. 308, Vol. II, Appendix 1, Sheet 3.

Climatological Data

The United States Weather Bureau does not maintain a station within the area. Beaver and Buffalo, Oklahoma, are adjacent to the area and their average monthly and annual precipitation records are presented below as being indicative of the precipitation received in the area discussed in this report.

Beaver, Oklahoma

Average Monthly and Annual Precipitation
in inches
Elevation - 2,500 feet

Month	Inches
January	.41
February	.77
March	.97
April	1.77
May	2.54
June	2.70
July	2.10
August	2.35
September	2.16
October	1.39
November	.93
December	.72
Annual	18.81

Buffalo, Oklahoma
Average Monthly and Annual Precipitation
in inches
Elevation - 1,850 feet

Month	Inches
January	.61
February	.86
March	1.32
April	1.87
May	3.25
June	3.55
July	2.12
August	2.57
September	2.56
October	1.44
November	1.25
December	.82
Annual	22.18

General Geology

The geologic formations outcropping over the watershed belong to the Permian, Cretaceous, Tertiary, and Quaternary systems.

Quaternary alluvium deposits occur in the valley of Beaver River, which traverses the area in northwest-southeast direction. These deposits are of varying thickness, lying unconformably upon the Permian "red beds." Terrace deposits and dune sands, also of Quaternary age, outcrop along the entire northern boundary of the area. These deposits are also present at the surface in the southern and western portions of the area. Likewise, these deposits rest unconformably upon the "red beds," hence their average thickness is unknown.

The Cloud Chief formation is the only member of the "red beds" series present at the surface in this area. This formation consists of red clays and shales interbedded with gypsum beds of considerable magnitude. It appears at the surface over a large part of the area, extending from the southeast through the west central.

Late Tertiary sands and gravels form the surface in the extreme southern and southwestern parts of the area. These deposits are also present at the surface over a small area in the northwestern part of the area between Kiowa Creek and Beaver River.

Cretaceous deposits outcrop in two small areas as indicated on Plate 1 but do not affect the water supply.

Ground-water Occurrence and Use

The principal aquifers in this area are the Quaternary dune sands and alluvium deposits, and the Tertiary sands and gravels. Numerous wells, throughout the areas where these formations are present, are producing water of satisfactory quality and in quantities sufficient for both stock and domestic purposes. These wells range in depths from 10 to 200 feet.

The "red beds" will usually yield water in quantities sufficient for stock and domestic purposes, however, the high degree of mineralization makes this water unfit for human consumption.

The Quaternary alluvium deposits in the valley of Beaver River yield potable water in quantities sufficient for stock and domestic purposes. Locally, these deposits are capable of yielding water in

quantities sufficient for irrigation. Existing irrigation wells have proven that, locally, this is true. At the present time there are nine wells in operation, ranging in depths from 25 to 40 feet. It is estimated that the combined annual recovery of these wells approximates 450 acre-feet.

Concerning these deposits, and irrigation developments, the following extracts are quoted from a report on this area compiled by the Resettlement Administration.[1]

"The only stratum that affects the hydrology of this area is the recent deposits of alluvium. These are supported by "red beds" that are classified as Cloud Chief Gypsum. The "red beds" merely serve as a floor to the water bearing sands and gravels and have no other bearing upon the problem under consideration. These beds are of the Permian period but they are mixed in scattered spots with Cretaceous showings of the Washita group. The uneven surface of the beds gives evidence of wind and water erosion prior to the time, and during the time, these quaternary deposits were laid down. These valley fills are irregular in thickness and extent; their occurrence is unpredictable and their water yielding capacities vary within short distances. According to well logs as listed for the area, the fills are generally lenticular in shape but are not deposited with true regard to density and diameter of the aggregate that makes up the fills. See Exhibit IX. These fills are predominately of the finer

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[1] Preliminary Report on the Water Supply on the Laverne Project, Laverne, Oklahoma, R. A. Project RR-OK-14; Dec. 1936, pp. 10 and 11, 16, 17, and 18.

textures that yield less water than do the coarser unconsolidated gravels that give up their waters more freely.

"These gravel lenses will probably be found to be confined with regard to lateral extent. The narrower channels of the upstream sections give a higher velocity of flow and the waters bear a heavier load of suspended matter than would be possible if the stream were less swift. Wider banks and broader channels initiate quiescence and permit the gravel to settle out in direct proportion to the destruction of the buoying force. It is these beds of gravel, or sands and gravel, that are capable of yielding large quantities of water. The extent of these beds are unknown and their source of replenishment has not been established. Old creek channels may inter-connect these deposits so as to permit subterranean flows that allow for a common water table for contiguous tracts. Expectations of recovery from each aquifer must remain an unknown quantity for the time being and no irrigation development should be attempted until a drilling test is made for that particular location.

"Since there is no accumulated data available that will define the water recovery and replenishment for this area, no definite recommendations are in order except consideration for further investigation provided the pre-requisite procedure involved justifies the spending of money for defining the texture, permeability, and contact lines of the aquifying strata.

"Irrigation in this area has been given no widespread development. Some individual development has been attempted during the

past three years but irrigation from these wells remains in the experimental stage. There are eight wells in the area that are used for irrigation purposes. Three of these units, located east of the town of Laverne, have been pumped for periods of twenty-four hours with no appreciable effect on the performance of the supply. A plot showing well locations is listed as Exhibit V. These units are listed as numbers 24, 25, and 55. These wells discharge from 400 to 900 g.p.m. through centrifugal pumps that are set just above the water table. The pumps are located in pits with drive belts leading up to a power plant that rests on the surface of the ground. This type of pump setting gets a quicker pick-up and favors the procedure of teeing off from the main suction line and connecting with individual drive points that go to make up a battery of feeders. These feeders are equipped with screens and are usually about 4 inches in diameter. Such an arrangement is designed to increase the disturbance area and to decrease the drawdown. The results from such an arrangement appear to be fairly satisfactory. The city of Laverne has a similar installation for the municipal water supply. The supply is comprised of two pumping units, located approximately 50 feet apart. The centrifugals are set at 15 feet below the ground level and a measured two feet above the water table when inspected during the month of July 1936. The pumper reported that both units had been operated simultaneously at 375 g.p.m. each for twenty-four periods and the drawdown was measured at 3 feet. No return was

recorded. It was further stated that a capacity draft on one unit had no noticeable effect on the other unit. The log for these wells shows the aquifer at 17 feet and it grades from fine sand to gravel of approximately 2 inches in diameter. The exact thickness of the gravel is not revealed by the log but it is regarded as about 30 feet. These wells penetrate the gravels that have been deposited in the old creek channels by the incipient quiescence of the waters as the spreading areas of confluence checked the rates of flow. These deposits were apparently greatly influenced by the undulations of the "red bed" floor that supports these valley fills.

"Since there are no previously compiled authentic hydrologic data available regarding the shallow ground waters in these valley fills, it naturally follows that extensive core testing would be necessary in an effort to define the line of contact between the "red beds" and the fills, and help to show the extensiveness of the courser unconsolidated beds. A study of the well logs in the area—allowing for the errors that the drillers include by reporting from memory—shows that there are no common alluvial strata that extend for any predictable source, that the hydrology is not uniform, and that the water recovery must be regarded as an individual problem for each tract. Some wells will discharge 650 g.p.m. while others furnish only enough for a domestic water supply. One well driller reported a recently drilled test (July 1936) that revealed but 2 feet of sand and gravel above the "red beds." The test was drilled 80 feet. This well was drilled in the southwestern part of the town of Laverne. Such irregularities as this and other logs reveal

in the acquifying strata concrete evidence of the necessity for a fairly extensive survey with a core drill."

Since the completion of the Resettlement report, personnel of the Water Utilization Section have made additional reconnaissance surveys of the area, and the results are shown on Plate 2. Sufficient data are now available to recommend irrigation on several tracts, totaling about 2,500 acres. These areas are shown on Plate 2 as "irrigable land - not alkali - and believed to be underlain by gravel." It is also recommended that final plans for each pump installation be contingent upon proof of 30 feet or more of water bearing gravels.

Surface Water

The average annual run-off per square mile of drainage area, as measured on the North Canadian (Beaver) River, at Woodward is about 23 acre-feet, or slightly less than two per cent of the average annual precipitation.[1]

Permian "red beds" constitute only a small percentage of the surface area included in the total drainage area down to the Woodward gaging station. Therefore the unit run-off of 23 acre-feet is only indicative of run-off over the Tertiary and Quaternary areas. Results of discharge measurements on the Washita River at Clinton, Oklahoma, are indicative of run-off over the "red bed" areas as the

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[1] Corps of Engineers, Arkansas River and Tributaries - House Doctrine No. 308 - 74th Congress, 1st Session - Volume 2 - Appendix 3, Table 5, Page 1064.

greater part of the surface of the Washita watershed is covered by these deposits. The Clinton discharge records indicate a run-off approximating 4 per cent of the average annual precipitation. Applying this factor to the area treated by this report, the unit run-off over the "red bed" areas will be about 46 acre-feet.

Soils

Herewith is presented verbatim the soils report by Mr. A. B. Beaumont, Land Classification Unit, Resettlement Administration, Region 8. This report is pertinent to the area shown on Plate 2.

> "The soils of this area are derived from stream terraces, and have been considerably modified by wind action. The topography is flat to rolling. In the eastern part of the area the topography is too rolling or hummocky for cultivated crops, and is best suited to use for pasture. In the western part, also, the surface is too irregular for easy irrigation.
>
> "Most of the soils of the area are tentatively classified in the Reinach series. They are light grayish brown, chocolate brown and dark brown, friable, sandy loams underlaid by light brown, salmon colored, or yellowish red medium to fine sandy loams or loamy sandy which in some cases graded into almost pure sand. The depth of the sandy subsoil is unknown, as it was sampled to a depth of only 3.5 feet, but judging from well borings, it appears to extend to depth of 20 feet or more and probably grades into gravel at the greater depths.
>
> "Considerable variation in the texture of the soils was noted both laterally and vertically. Generally, the surface soils of the Reinach series were found to be somewhat heavier and more retentive of moisture than the subsoil, but this was not invariable. Two places were found where the subsoil was a tight, very fine sandy loam or silt loam. The sandy subsoil is more or less interbedded with layers of heavier loams.

"On the slope in the southern part of the area, and more or less on knolls, the soils were reddish brown or brick red, and probably belong to the Vernon series or have been considerably modified by the presence of wind-blown Vernon material. These reddish soils are generally heavier and probably less fertile than the Reinach soils found at the lower elevations.

"All the soils of this area have an alkaline reaction and most of them are calcareous. Concretionary "caliche" (Calcium carbonate) was found in most of the subsoils at a depth of 18 to 24 inches. Judging by the appearance of crops and trees growing on the Reinach soils, and by chemical tests made by Dr. H. J. Harper of the Agronomy Department of the Oklahoma A. and M. College, these soils are naturally fertile and will be productive if properly managed. With the possible exception of areas from which the surface soil has been removed in levelling operations, commercial fertilizers will not be generally needed. Water is the most general limiting factor for crop production on these soils.

"Water-bearing sands or gravels underlie most of the area under consideration. Two farmers in the vicinity of Laverne have installed motor driven pumps which deliver large and ample quantities of water for irrigation. It is thought by those familiar with the local situation that the underground supply of water is sufficient for all reasonable demands, but this belief should be checked as closely as possible before intensive development of the area is undertaken. Chemical analysis of several water samples taken at scattered points in the area show the underground water to be of excellent quality for domestic and irrigation purposes. Following is a copy of the report on chemical composition made by Dr. H. J. Harper of Oklahoma A. and M. College."

> "I have analysed the water samples you left in my laboratory for chlorine content and have made a qualitative test for sulphate. I also titrated this material to determine the bicarbonate content and find that it is very low. The PH will vary from 74. to 7.6."

Sample No.	Name and Location	Depth	Type of Well	Pts./million of Chlorine	Sulphate Content
1.	D.C. Hickman, NE$\frac{1}{4}$ Sec.19	....	Windmill	13.0	Slight
2.	H.C. Holmes, Laverne	5-32'	Pump	10.5	Slight
3.	A.L. Lamunyon, SW$\frac{1}{4}$ Sec.32	....	Windmill	2.8	Very Slight
4.	C.E. Delhotal, 2mi. S$\frac{1}{4}$E	30'	Windmill	2.4	High
5.	John Maulman, S$\frac{1}{2}$SW$\frac{1}{4}$ Sec.18	....	Windmill	12.3	Very Slight
6.	Water from Hotel in Laverne		Pump	4.2	Very Slight

"It will be noted that the chlorine content is low in all cases, and that the sulphate content is low in all cases except that of Delhotal. The well from which this sample came is south of the project areas and may be disregarded for the purpose of this project.

"The topography and nature of the surface soils of the major part of this area are ideal for irrigation purposes. Absorption of water would be fairly rapid. Retentiveness of the subsoils for water is not as high as would be considered most desirable, but judging by the experience of those now irrigating, some of which is on the more sandy soils, there is sufficient clay and silt in the subsoils to make them fairly retentive of moisture. Retentiveness of the subsoil is far from uniform. Some sections of high porosity are to be found, while in others the subsoils are highly retentive.

"With the exceptions already noted, dry farming is commonly practiced in the area. Wheat, grain sorghums, and alfalfa are the most common crops. Orchards and gardens do well under irrigation. The principal soils of the area are well adapted to row crops and alfalfa. Tap-rooted crops of all kinds will do well in the loose, friable, sandy loams. Asparagus should do especially well on these soils and would have the advantage of offering much protection against wind erosion. Alfalfa should be given prime consideration as a staple forage crop if the project is developed."

Present Land Use

It is estimated that 60 per cent of the land is in native pasture and 40 per cent in cultivation. Approximately 2 per cent of the crop land has been turned to restoration. At the present time eight operators are irrigating a total of 350 acres along the North Canadian River. These areas are outlined on Plate 2. Crop yields on irrigated lands are estimated as follows: alfalfa, $2\frac{1}{4}$ tons per acre; alfalfa seed, 3 bushels per acre; and wheat, 35 bushels per acre.

PROPOSED AREA UTILIZATION

Stock and Domestic

It is recommended that surface water development consist of the surface retention of stock water supplies, and of flood irrigation of native pastures. Inadequate storage facilities are conducive to seasonal water shortage. This may be alleviated since the annual water supply is sufficient in amount to fulfill the requirements of storage necessary for both stock and domestic needs.

The construction of small dams and reservoirs for stock watering purposes is applicable throughout the area. Careful investigation of sites located in the "red bed" areas is recommended in view of the solubility in water of gypsum beds locally present in the Permian formations.

The development of ground-water resources for both stock and domestic purposes is recommended in all Tertiary and Quaternary areas as outlined on Plate 1. Throughout the "red bed" areas, ground-water development is recommended for stock purposes only.

Irrigation

It is reported that Oklahoma City is soon to instigate court action against water users in the North Canadian (Beaver) watershed.

This stream is the source of the cities water supply. Therefore, it is recommended that any irrigation development in the area treated by this report be delayed, pending results of this suit.